Mathematics Curriculum Map

AP Statistics

AP Statistics– At a Glance

NOTE: Mathematical standards are interwoven and should be addressed throughout the year in as many different units and tasks as possible in order to stress the natural connections that exist among mathematical topics.

AP Statistics Curriculum Map

Semester 1			Semester 2	
Unit 1 **Exploring Data**	**Unit 2** **Sampling and Experimentation**	**Unit 3** **Anticipating Patterns**	***Unit 4*** **Statistical Inference**	**Unit 5** **AP Review/Project**
Graphical Displays: Univariate Data **Summarizing Distributions: Univariate Data** **Comparing Distributions: Univariate Data** **Exploring Bivariate Data** **Exploring Categorical Data**	**Methods of Data Collection** **Planning and Conduction Surveys** **Planning and Conduction Experiments** **Generalizability of Results and Types of Conclusions**	**Probability** **Combining Independent Random Variables** **The Normal Distribution** **Sampling Distributions**	**Point Estimators and Confidence Intervals** **Tests of Significance**	**Review/Project**

Standards are Based on the College Board Official Course Competencies

Mathematical Practices *:* All units will include the Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

AP Statistics Overview

I. Exploratory analysis of data makes use of graphical and numerical techniques to study Patterns and departures from patterns. In examining distributions of data, students should be able to detect important characteristics, such as shape, location, variability and unusual values. From careful observations of patterns in data, students can generate conjectures about relationships among variables. The notion of how one variable may be associated with another permeates almost all of statistics, from simple comparisons of proportions through linear regression. The difference between association and causation must accompany this conceptual development throughout.

II. Data must be collected according to a well-developed plan if valid information is to be obtained. If data are to be collected to provide an answer to a question of interest, a careful plan must be developed, both the type of analysis that is appropriate and the nature of conclusions that can be drawn from that analysis depend in a critical way on how the data was collected. Collecting data in a reasonable way, through either sampling or experimentation, is an essential step in the data analysis process.

III. Probability is the tool used for anticipating what the distribution of data should look like under a given model. Random phenomena are not haphazard: they display an order that emerges only in the long run and is described by a distribution. The mathematical description of variation is central to statistics. The probability required for statistical inference is not primarily axiomatic or combinatorial but is oriented toward using probability distributions to describe data.

IV. Statistical inference guides the selection of appropriate models. Models and data interact in statistical work: models are used to draw conclusions from data, while the data are allowed to criticize and even falsify the model through inferential and diagnostic methods. Inference from data can be thought of as the process of selecting a reasonable model, including a statement in probability language, of how confident one can be about the selection.

Standards for Mathematical Practices (MP)

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Semester 1

Unit 1 - Exploring Data

Essential Question(s):

- **How can data be organized and interpreted in meaningful ways?**

Topic	AP Statistics College Board Competencies	Mathematical Practices	Resources
Constructing and interpreting graphical displays of distributions of univariate data	• Center and Spread • Clusters and Gaps • Outliers and Unusual Features • Shape	MP 1 MP 4 MP 5 MP 7	• Starnes et al. 1.2 • Starnes et al. 1.2 • Starnes et al. 1.2 • Starnes et al. 1.2
Summarizing distributions of univariate data	• Measuring center: median, mean • Measuring spread: range, IQR, standard deviation • Measuring position: quartiles, percentiles, standardized scores (z-scores) • Using boxplots • The effect of changing units on summary measures	MP 1 MP 4 MP 5 MP 6	• Starnes et al. 1.3 • Starnes et al. 1.3 • Starnes et al. 1.3, 2.1 • Starnes et al. 1.3 • Starnes et al. 1.3
Comparing distributions of univariate data	• Comparing center and spread • Comparing clusters and gaps • Comparing outliers and unusual features • Comparing shape	MP 1 MP 4 MP 5 MP 7	• Starnes et al. 1.2 and 1.3 • Starnes et al. 1.2 and 1.3 • Starnes et al. 1.2 and 1.3 • Starnes et al. 1.2 and 1.3
Exploring bivariate data	• Analyzing patterns in scatterplots • Correlation and linearity • Least-squares regression line • Residual plots, outliers, and influential points • Transformations to achieve linearity: logarithmic and power transformations	MP 1 MP 4 MP 5 MP 6 MP 7	• Starnes et al. 3.1 • Starnes et al. 3.1 • Starnes et al. 3.2 • Starnes et al. 3.2 • Starnes et al. 12.2
Exploring Categorical Data	• Frequency tables and bar charts • Marginal and joint relative frequencies and association • Conditional relative frequencies and association • Comparing distributions and using bar charts	MP 1 MP 4 MP 5	• Starnes et al. 1.1 • Starnes et al. 1.1, 5.2 • Starnes et al. 1.1, 5.3 • Starnes et al. 1.1

Semester 1

Unit 2 – Sampling and Experimentation: Planning and Conducting a Study

Essential Question(s):

- **What are the appropriate methods for collecting data in a meaningful and ethical way?**

Topic	AP Statistics College Board Competencies	Mathematical Practices	Resources
Overview of Methods of Data Collection	• Census • Sample Survey • Experiment • Observational Study	MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	• Starnes et al.4.1 • Starnes et al.4.1 • Starnes et al.4.2 • Starnes et al.4.2
Planning and Conducting Surveys	• Characteristics of a Well-Designed and Well-Conducted Survey • Populations, Samples, and Random Selection • Sources of Bias in Sampling and Surveys • Sampling Method, Including Simple Random Sampling, Stratified Random Sampling, and Cluster Sampling		• Starnes et al. 4.1 • Starnes et al. 4.1 • Starnes et al. 4.1 • Starnes et al. 4.1
Planning and Conducting Experiments	• Random Randomized Design • Treatments, Control Groups, Experimental Unit, Random Assignments, and Replication • Source of Bias and Confounding, including Placebo Effect and Blinding • Completely Randomized Design • Randomized Block Design, including Matched Pairs Design		• Starnes et al. 4.2 • Starnes et al. 4.2 • Starnes et al. 4.2 • Starnes et al. 4.2 • Starnes et al. 4.2
Generalizability of Results and Types of Conclusions that can be Drawn from Observational Studies, Experiments, and Surveys	• Generalizability of Results and Types of Conclusions that can be Drawn from Observational Studies, Experiments, and Surveys		• Starnes et al. 4.3

Semester 1

Unit 3 – Anticipating patterns: exploring random phenomena using probability and simulation

Essential Question(s):

- **How do you interpret and calculate probability for random phenomena?**

Topic	AP Statistics College Board Competencies	Mathematical Practices	Resources
Probability	• Interpreting probability, including long-run relative frequency interpretation • "Law of large numbers" concept • Addition rule, multiplication rule, conditional probability, and independence • Discrete random variables and their probability distributions, including binomial and geometric • Simulations of random behavior and probability distributions • Mean and standard deviation of a random variable, and linear transformation of a random variable	MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	• Starnes et al. 5.1 • Starnes et al. 5.1 • Starnes et al. 5.2, 5.3 • Starnes et al. 6.1, 6.3 • Starnes et al. 5.1 • Starnes et al. 6.1, 6.2
Combining independent random variables	• Notion of independence versus dependence • Mean and standard deviation for sums and differences of independent random variables		• Starnes et al. 6.2 • Starnes et al. 6.2
The Normal distribution	• Properties of the Normal distribution • Using tables of the Normal distribution • The Normal distribution as a model for measurements		• Starnes et al. 2.2 • Starnes et al. 2.2 • Starnes et al. 2.2
Sampling Distributions	• Sampling distributions of a sample proportion • Sampling distribution of a sample mean • Central limit theorem • Sampling distribution of a difference between two independent sample proportions • Sampling distribution of a difference between two independent sample means • Simulation of sampling distributions • t distribution • Chi-square distribution		• Starnes et al. 7.2 • Starnes et al. 7.3 • Starnes et al. 7.3 • Starnes et al. 10.1 • Starnes et al. 10.2 • Starnes et al. 7.1 • Starnes et al. 8.3 • Starnes et al. 11.1

Semester 2

Unit 4 - Statistical Inference
Essential Question(s):

- **How do you verify that a claim is statistically significant?**

Topic	AP Statistics College Board Competencies	Mathematical Practices	Resources
Estimation (Point Estimators and Confidence Intervals	• Estimating population parameters and margins of error • Properties of point estimators, including unbiasedness and variability • Logic of confidence intervals, meaning of confidence level and confidence intervals • Large-sample confidence interval for a proportion • Large-sample confidence interval for a difference between two proportions • Confidence interval for a mean • Confidence interval for a difference between two means (unpaired and paired) • Confidence interval for the slope of a least-squares regression line	MP 1 MP 2 MP 3 MP 4 MP 5 MP 6 MP 7 MP 8	• Starnes et al. 8.1 • Starnes et al. 8.1 • Starnes et al. 8.1 • Starnes et al. 8.2 • Starnes et al. 10.1 • Starnes et al. 8.3 • Starnes et al. 9.3 (paired) • Starnes et al. 10.2 (unpaired) • Starnes et al. 12.1
Test of Significance	• Logic of significance testing, null and alternative hypotheses; P-values; one- and two-sided tests • Large-sample test for a proportion • Large-sample test for a difference between two proportions • Test for a mean • Test for a difference between two means (unpaired and paired) • Chi-square test for goodness of fit, homogeneity of proportions, and independence (one- and two-way tables) • Test for the slope of a least-squares regression line		• Starnes et al. 9.1 • Starnes et al. 9.2 (power) • Starnes et al. 9.2 • Starnes et al. 10.1 • Starnes et al. 9.3 • Starnes et al. 9.3 (paired) • Starnes et al.10.2 (unpaired) • Starnes et al.11.1, 11.2 • Starnes et al.12.1

Semester 2

Unit 5 - Review/Project
Essential Question(s):

- **How do we have students use statistical design to question real-world problems?**

Topic	Statistics College Board Competencies	Mathematical Practices	Resources
AP Review	Practice for the Advanced Placement Exam		College board website released exams.
Project	The project draws connections between all aspects of the statistical process including design, analysis, and conclusions		College board

The Mathematical Practices: Narratives and Questions

Mathematics Practices		Narratives	Related Questions
Overarching habits of mind of a productive math thinker	**MP.1 Make sense of problems and persevere in solving them**	Mathematically proficient students explain to themselves the meaning of a problem, look for entry points to begin work on the problem, and plan and choose a solution pathway. While engaging in productive struggle to solve a problem, they continually ask themselves, "Does this make sense?" to monitor and evaluate their progress and change course if necessary. Once they have a solution, they look back at the problem to determine if the solution is reasonable and accurate. Mathematically proficient students check their solutions to problems using different methods, approaches, or representations. They also compare and understand different representations of problems and different solution pathways, both their own and those of others.	• How would you describe the problem in your own words? • How would you describe what you are trying to find? • What do you notice about...? • What information is given in the problem? • Describe the relationship between the quantities. • Describe what you have already tried. What might you change? • Talk me through the steps you've used to this point. • What steps in the process are you most confident about? • What are some other strategies you might try? • What are some other problems that are similar to this one? • How might you use one of your previous problems to help you begin? • How else might you organize...represent... show...?
	MP.6 Attend to precision	Mathematically proficient students clearly communicate to others using appropriate mathematical terminology, and craft explanations that convey their reasoning. When making mathematical arguments about a solution, strategy, or conjecture, they describe mathematical relationships and connect their words clearly to their representations. Mathematically proficient students understand meanings of symbols used in mathematics, calculate accurately and efficiently, label quantities appropriately, and record their work clearly and concisely.	• What mathematical terms apply in this situation? • How did you know your solution was reasonable? • Explain how you might show that your solution answers the problem. • What would be a more efficient strategy? • How are you showing the meaning of the quantities? • What symbols or mathematical notations are important in this problem? • What mathematical language...,definitions..., properties can you use to explain...? • How could you test your solution to see if it answers the problem?

Actions and dispositions from NCSM Summer Leadership Academy, Atlanta, GA • Draft, June 22, 2011)
Most questions from all Grades Common Core State Standards Flip Book

The Mathematical Practices: Narratives and Questions

Mathematics Practices		Narratives	Related Questions
Reasoning and Explaining	**MP.2 Reason abstractly and quantitatively**	Mathematically proficient students make sense of quantities and their relationships in problem situations. Students can contextualize and decontextualize problems involving quantitative relationships. They contextualize quantities, operations, and expressions by describing a corresponding situation. They decontextualize a situation by representing it symbolically. As they manipulate the symbols, they can pause as needed to access the meaning of the numbers, the units, and the operations that the symbols represent. Mathematically proficient students know and flexibly use different properties of operations, numbers, and geometric objects and when appropriate they interpret their solution in terms of the context.	• What do the numbers used in the problem represent? • What is the relationship of the quantities? • How is _____ related to _____? • What is the relationship between _____and _____? • What does_____mean to you? (e.g. symbol, quantity, diagram) • What properties might we use to find a solution? • How did you decide in this task that you needed to use...? • Could we have used another operation or property to solve this task? Why or why not?
	MP.3 Construct viable arguments and critique the reasoning of others	Mathematically proficient students construct mathematical arguments (explain the reasoning underlying a strategy, solution, or conjecture) using concrete, pictorial, or symbolic referents. Arguments may also rely on definitions, assumptions, previously established results, properties, or structures. Mathematically proficient students make conjectures and build a logical progression of statements to explore the truth of their conjectures. They are able to analyze situations by breaking them into cases, and can recognize and use counterexamples. Mathematically proficient students present their arguments in the form of representations, actions on those representations, and explanations in words (oral or written). Students critique others by affirming or questioning the reasoning of others. They can listen to or read the reasoning of others, decide whether it makes sense, ask questions to clarify or improve the reasoning, and validate or build on it. Mathematically proficient students can communicate their arguments, compare them to others, and reconsider their own arguments in response to the critiques of others.	• What mathematical evidence would support your solution? • How can we be sure that...? / How could you prove that...? • Will it still work if...? • What were you considering when...? • How did you decide to try that strategy? • How did you test whether your approach worked? • How did you decide what the problem was asking you to find? • Did you try a method that did not work? Why didn't it work? Could it work? • What is the same and what is different about...? • How could you demonstrate a counter-example?

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The Mathematical Practices: Narratives and Questions

Mathematics Practices		Narratives	Related Questions
Modeling and Using Tools	**MP.4 Model with mathematics**	Mathematically proficient students apply the mathematics they know to solve problems arising in everyday life, society, and the workplace. When given a problem in a contextual situation, they identify the mathematical elements of a situation and create a mathematical model that represents those mathematical elements and the relationships among them. Mathematically proficient students use their model to analyze the relationships and draw conclusions. They interpret their mathematical results in the context of the situation and reflect on whether the results make sense, possibly improving the model if it has not served its purpose.	• What number model could you construct to represent the problem? • What are some ways to represent the quantities? • What is an equation or expression that matches the diagram, number line, chart, table, and your actions with the manipulatives? • Where did you see one of the quantities in the task in your equation or expression? What does each number in the equation mean? • How would it help to create a diagram, graph, table...? • What are some ways to visually represent...? • What formula might apply in this situation?
	MP.5 Use appropriate tools strategically	Mathematically proficient students consider available tools when solving a mathematical problem. They choose tools that are relevant and useful to the problem at hand. Proficient students are sufficiently familiar with tools appropriate for their grade or course to make sound decisions about when each of these tools might be helpful; recognizing both the insight to be gained and their limitations. Students deepen their understanding of mathematical concepts when using tools to visualize, explore, compare, communicate, make and test predictions, and understand the thinking of others.	• What mathematical tools can we use to visualize and represent the situation? • Which tool is more efficient? Why do you think so? • What information do you have? • What do you know that is not stated in the problem? • What approach are you considering trying first? • What estimate did you make for the solution? • In this situation would it be helpful to use...a graph..., number line..., ruler..., diagram..., calculator..., manipulative? • Why was it helpful to use...? • What can using a _____ show us that _____may not? • In what situations might it be more informative or helpful to use...?

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The Mathematical Practices: Narratives and Questions

Mathematics Practices		Narratives	Related Questions
Seeing structure and generalizing	**MP.7 Look for and make use of structure**	Mathematically proficient students use structure and patterns to assist in making connections among mathematical ideas or concepts when making sense of mathematics. Students recognize and apply general mathematical rules to complex situations. They are able to compose and decompose mathematical ideas and notations into familiar relationships. Mathematically proficient students manage their own progress, stepping back for an overview and shifting perspective when needed.	• What observations do you make about...? • What do you notice when...? • What parts of the problem might you eliminate..., simplify...? • What patterns do you find in...? • How do you know if something is a pattern? • What ideas that we have learned before were useful in solving this problem? • What are some other problems that are similar to this one? • How does this relate to...? • In what ways does this problem connect to other mathematical concepts?
	MP.8 Look for and express regularity in repeated reasoning	Mathematically proficient students look for and describe regularities as they solve multiple related problems. They formulate conjectures about what they notice and communicate observations with precision. While solving problems, students maintain oversight of the process and continually evaluate the reasonableness of their results. This informs and strengthens their understanding of the structure of mathematics which leads to fluency.	• Explain how this strategy works in other situations? • Is this always true, sometimes true or never true? • How would we prove that...? • What do you notice about...? • What is happening in this situation? • What would happen if...? • Is there a mathematical rule for...? • What predictions or generalizations can this pattern support? • What mathematical consistencies do you notice?

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